ATEST GAZ

User's Manual

Gas Detector

SmArtGas 3 / Sigma SmArt

Product code:

PW-044-A-SG-X / PW-044-A-SS-X

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1 Remarks and claims

- Connection and exploitation of the detector is allowed only after the content of this document has been thoroughly read and clearly understood.
- Only qualified staff that possess necessary knowledge, experience and certificates with respect to carrying out installation tasks in the potentially explosive atmospheres is allowed to fit electric equipment in the potentially explosive areas.
- The manufacturer bears no responsibility for any faults, damages and breakdowns being a result of incorrect selection of the equipment, improper installation and omissions in understanding content of this document.
- No self-willed repairs or tampering of the equipment are allowed. The manufacturer bears no responsibility for results of unauthorized maintenance.
- Excessive mechanical impact, electric shock or environmental exposure may lead to the damage to the equipment. Exploitation of damaged or incomplete appliances is forbidden.
- This document contains information of general nature, related to the entire family of appliances. due to the fact that exploitation conditions may strongly depend on the type of the working agent and environmental exposure the forthcoming requirements are supplemented by the “detailed exploitation requirements” whenever such a supplement proves to be necessary.
- The “Report from inspection of gas measurement installation” that contain detailed inspection schedule presents an inseparable part of this documentation.
- The user on his own is obliged to get familiar with the legal regulations in force and effective during the exploitation period, in particular with the applicable rules or assembling the electric equipment and laying electric cables within vicinity of the potentially explosive areas. According to the manufacturer’s opinion getting familiar and obeying the rules included into the following standards is indispensable.

  EN 60079-14 “Electric equipment in the potentially explosive areas. Part 14 – electric systems and wirings in the potentially explosive areas”.

  EN 60079-17 “Electric equipment in the potentially explosive areas. Part 17 – inspection and maintenance of electric installations in the potentially explosive areas”.

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2 Description and application area

2.1 Designation and operation principle

The Gas Detectors SmArtGas 3 / Sigma SmArt are fixed-mounted appliances, designed for detection and monitoring the concentration of toxic and flammable gases as well as the level of oxygen in the surrounding atmosphere.

The detector measures concentration of the specific component and converts the measured value into the analogue current signal or digital code depending on the detector type (see forthcoming description). Beside the measurement the detector analyses the measured value of gas concentration and can produce warning and alarm signals when the following threshold levels are exceeded:

- warning 1,
- warning 2,
- alarm,
- gas overload (hazard of damage to the detector).

Moreover, the detectors are self-diagnostic appliances and warn the user in case of any irregularities detected in the operation of the units themselves.

2.2 Construction

The unit is composed of the following parts:

- housing (junction box) of aluminium alloys, coated with appropriate epoxide paint for protection against environmental impacts,
- measuring head that houses the gas-detecting component (sensor), the head is made of acid resistant steel,
- one or two cable glands,
- microprocessor module – the electronic amplifier and the measuring transducer.

2.3 Explosion-proof features

Al explosion-proof features are described in Appendix A2 (EC Declaration of Conformity).

2.4 Functionalities

Microcontroller processor -based construction	Makes it possible to offer advanced and competitive operational parameters as compared to conventional solutions based on the analogue electronic circuits. Advantages of the microprocessor technique include: • readouts and linearization of the measured signals, • compensation of temperature bias from the environment, • switching the detector between the specific operation modes (eg. calibration, alarm, etc.) • self-diagnostic functions of the appliance.
On-site conversion of the measured signals	Instantaneous conversion of the measurement signal into digital form that is carried out as early as inside the detector increases reliability of the detector and its tolerance to interferences.
No mechanical control components	All the settings are stored in the non-volatile detector memory which makes it possible to get rid of potentiometers, switches and similar controls. Such a solution significantly increases reliability of the device.
Intrinsically safe self-testing and adjustments	The detector being equipped with the RS-485 port can be calibrated in the zone of potentially explosive atmosphere with no need to interfere inside the housing of the device. In most cases even dismounting from the place of installation is not necessary.
Flexible configuration of the output signal	The output signal can be transmitted from the detector outputs in different forms: • analogue signal of electric current 4 .. 20 mA, • digital signals of the RS-485 port, • voltage potentials (relay outputs). More advanced models enable concurrent use of whichever two signals.
Intrinsically safe in-fly configuration through the serial port	Values for the alarm thresholds can be modified by the operator with no downtime of the system (version with the RS-485 port).
Emulated operation	Makes it possible to verify operation condition of the system and correctness of its functionalities with no nee to deliver real gas.
Self-test facilities	The following functionalities are checked: • power supply for the sensor, • overloads • time intervals between maintenance operations • faults (defects) of the microprocessor memory

Table 1: Functionalities

2.5 Output signal

Depending on the user's needs the detector can operate with output circuits in the following configuration:

- conventional current loop 4 .. 20 mA (see chapter 9)

  makes it possible to easily integrate the detectors with other components of the automatic monitoring system, e.g. with Programmable Logic Controllers (PLC). Detectors with such types of outputs are distinguished by the "420" marking.

  - values below 4 mA correspond to failure states of the detector,
  - value of 4 mA indicates no content of the measured gas (zero concentration),
  - value of 20 mA refers to the maximum declared operation range of the detector (or even higher concentration (saturation of the detector),
  - the electric current that corresponds to the specific concentration of the monitored gas can be calculated by the following formula:

$$I = 4\ mA + 16\ mA * \frac{\text{CONCENTRATION OF GAS AS DELIVERED TO THE DETECTOR}}{\text{MEASUREMENT RANGE OF THE DETECTOR}}$$

- digital port by the RS-485 standard

  It is the basic solution, recommended by the manufacturer. It enables easier integration with SCADA (supervisory control and data acquisition).

  - Data transmission through the RS-485 port is carried out in accordance with the Sigma BUS protocol. Application of other data transmission protocols is also possible.

3 Design rules: selection of detectors, deployment, environment

3.1 Deployment of sensors

Location of specific sensors should be determined by the designer of the monitoring system and should take account for such factors as:

3.1.1 density of the monitored agent as compared to the air density. The general rule imposes that the detectors for light gases should be installed about 30 cm below the roof of the closed area while the sensors for heavy gases – about 30 cm above the ground,

3.1.2 possible areas where the gas can be potentially accrued (gas accumulation) due to insufficient ventilation or lack of it or caused by specific constructional qualities of the structure (e.g. the roof -adjacent area separated from the other compartments by bearing support or other components),

3.1.3 The SmArtGas 3 / Sigma SmArt detectors are connected with the supervising digital system through the four-wired two-pair twisted cable. Two wires are used for data transmission while the two other ones serve as power supplying lines. The twisted cable present the power supplying and communication bus for the entire system, the total length of the bus depend from power consumption of detectors and wire dimensions but must be less than 1,200 m.

3.1.4 influence of the gas temperature: gases that are normally heavier than air can become lighter after heating up and migrate upwards, however they may lower to the floor after cooling,

3.1.5 gas pressure and expected type of emission (outflow, outburst),

3.1.6 volatility of the gas – in case of gaseous agent with low volatility the detector must be located as close as possible to the expected place of the gas effluence,

3.1.7 impact of environmental conditions,

The detectors should be secured against exposure to direct flow of water or other chemicals – e.g. washing liquids being splashed when the plant facilities are cleaned. Take special care to avoid flooding /contamination of the steel sintered coating as it leads to damage of the detector and loss of its measurement functionalities.

The detector should be also protected against direct influence of dust, sunlight, rain and wind. If the detector are installed outdoors the relevant splash-protecting covers or “weather cabinets” should be applied. The detectors must not be exposed to direct impact of environmental factors. Disobeying of the above rules leads to damage of the sintered coating or measuring cell.

3.1.8 direction of air flow as enforced by ventilation – the detectors should be located along the ventilation ducts – from the place of possible effluence to the exhaust stack. If the ventilation duct varies four detectors should be disposed in such a way that the source of effluence will be surrounded. If outdoor installation proves to be necessary the expected wind direction must be taken into account,

3.1.9 probable location of humans with respect to the source of gas emission – the detector should be between the staff and the emission source,

3.1.10 being designed mechanical impacts – the detector is enclosed into the extremely rugged housing made of aluminium alloy, so the housing is insensitive to quite powerful impacts. Anyway, the detector must be protected against destructive forces. If any damages are disclosed on the housing, in particular defects of contact surface of explosion-proof connections, threads, sintered coating, etc., the detector must be switched off, connecting cables secured trustworthy and contact the manufacturer’s Service Department.

The above requirement must be strictly obeyed if the detector is installed in the zone with potentially explosive atmosphere

3.1.11 access – location of the device and the way of its installation must enable checking and calibration of the detector as well as its replacement or dismounting.

3.2 Environment

The following factors should be taken into account when the installation is being designed:

3.2.1 exposure to corrosive agents

The unit must be installed and exploited in the environment that presents no risk of corrosion to the applied materials. In spite of the fact that corrosion-resistant materials have been used for the design of the unit the user (or the system designer) should develop the "study of environmental hazards" that take into account the following factors:

- presence of such gases as SO2, HCl, H2S, NH3 as well as other corrosive gases, in particular at presence of moisture and mist,
- possible variation of the ambient temperature and matching the actual environmental conditions to the ones as declared in this documentation,

3.2.2 presence of reactive agents, such as HCl or Cl2 – the attention must be paid to the hazard of adsorption of the specific agent on the detector surface, in particular at presence of mist or moisture,

3.2.3 probable accumulation of dust, grease and other clogging materials that may obstruct free penetration of ambient gas into the measurement chamber.,

3.2.4 probable concentration of hot vapours from normally liquid substances (at ambient temperature, which presents hazard of condensation of that agent at the detector inlet and may result in blocking the detector,

3.2.5 ambient temperature

The actual temperature should correspond to the ranges as declared by the manufacturer. In particular during start-up and commissioning of the technological plant as well as in case of any malfunctioning and breakdowns the attention should be paid to the fact whether momentary exceeding of the permitted temperature limits have occurred. If so contact the manufacturer.

3.2.6 hazard of flooding the detector with water or other liquids,

3.2.7 if the detector is to be installed outdoors:

- the device must not be exposed to direct impact of environmental factors, installation of adequate splash-protection covers or "weather cabinets" is indispensable,
- the detector must be protected against condensation of liquids on its housing as it may lead to clogging the inlet sintered member. This protection can be reached e.g. by heating the detector by several degrees Celsius,

3.2.8 content of oxygen in the ambient atmosphere – in particular in case of a catalytic detectors oxygen content in the ambient atmosphere below 20% significantly decreases sensitivity of the detector. On the other hand one should remember that the explosion-proof acceptance of the unit applies if the oxygen content in the ambient atmosphere never exceeds 21%. If the oxygen concentration is higher that device loses its explosion-proof properties and may the source of ignition,

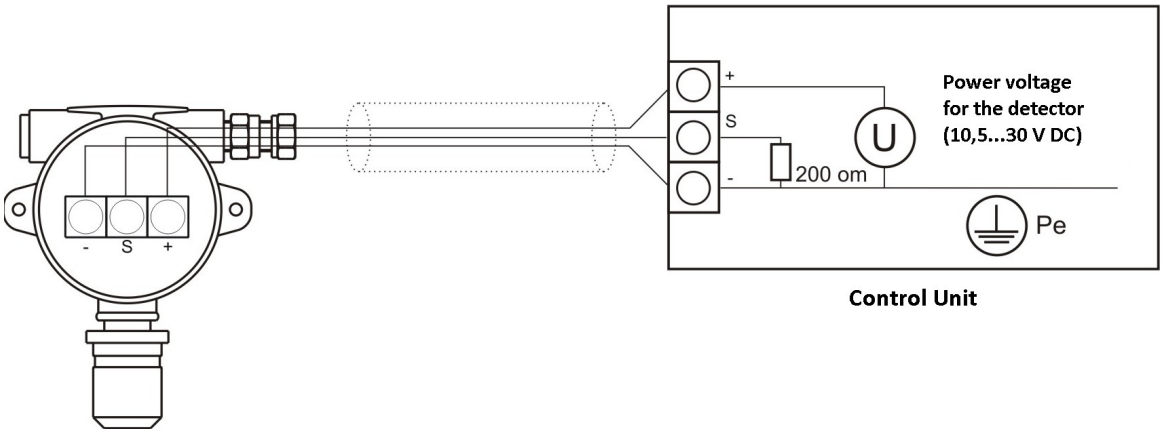
3.2.9 presence of other gaseous agent that may result in:

- faulty alarms – e.g. presence of aerosols if the semiconductor sensors are applied,
- poisoning of the detector – e.g. presence of silicones may lead to damage of catalytic detectors,
- aliasing of signals that are produced by the working agents – e.g. presence of hydrogen may override detection of carbon oxide by the electrochemical sensors,

- vibrations – excessive vibrations may lead to spontaneous loosening of bolts and cable glands. If the hazard of high power vibrations occurs appropriate hints should be incorporated into the technical documentation and impose the requirement of frequent inspection (e.g. blanket or screening inspections should be recommended as through as close visual examination.

4 Designing the electric systems for gas detectors

4.1 Detectors with 4 .. 20 mA (420) (not applicable Sigma SmArt)



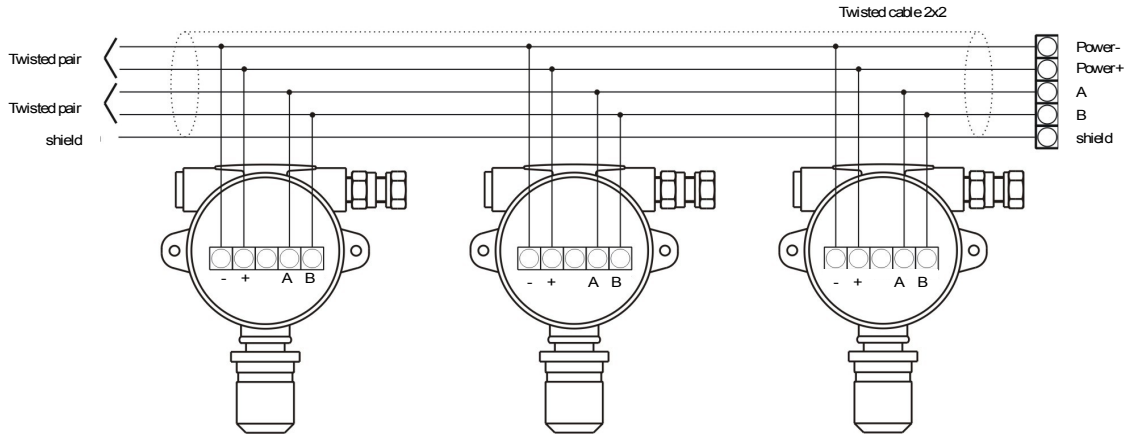
4.1.1 connection diagram for the detector,

4.1.2 range of recommended cross-section of wires: see chapter 9,every detector needs a separate transmission line,

4.1.3 length of the transmission line should not exceed 200 m.

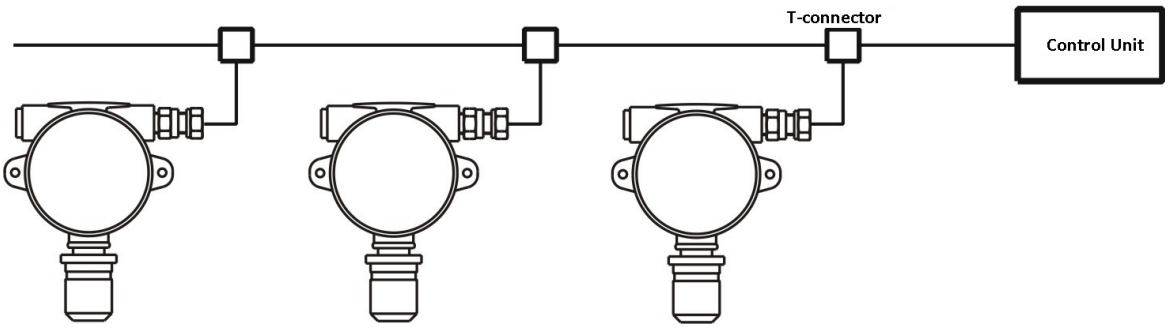
4.2 Detectors with the RS-485 serial port (485)

General structural diagram of the connections is shown below:

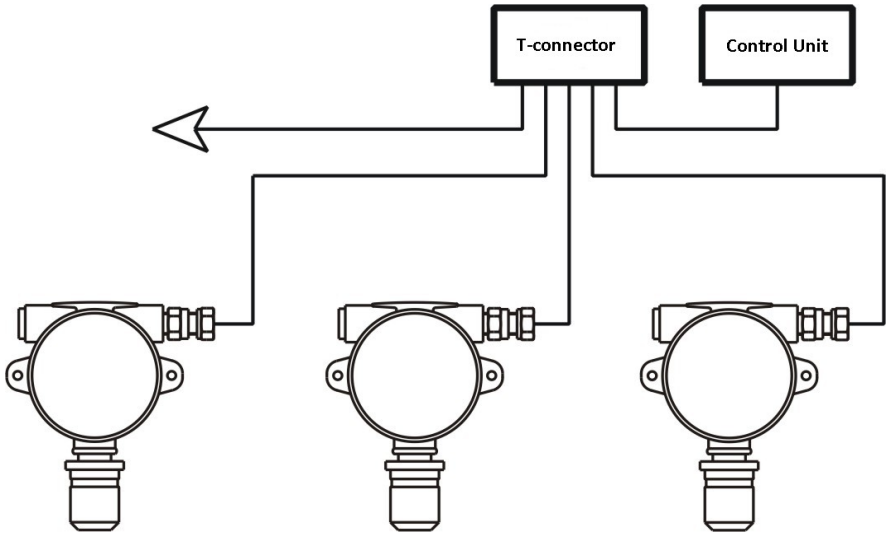


4.2.1 Various topologies for the network of the detectors:

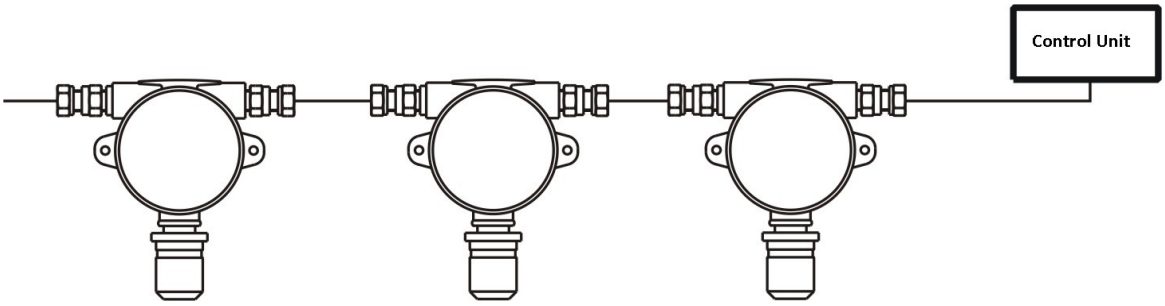
4.2.1.1 for the systems that incorporate dispersed detectors deployed far away from the Control Unit application of terminal boxes ALPA with T-connectors is recommended. The terminal boxes perform as network nodes where individual detectors can be connected to the system bus. The terminal boxes can be deployed whenever they are needed. The system bus with terminal boxes is traced through the entire plant whereas individual detectors are connected to the terminal boxes by separate four-wired twisted cables,



4.2.1.2 if the detectors are not very far one from another and the distance from the Control Unit is not very long the individual lines from each detector can be connected to a common terminal cabinet where they are mapped accordingly,



4.2.1.3 for the simplest solution the detectors are directly connected one with another and form a series of units (not recommended),



4.2.2 Designing procedure – selection of cables, see Appendix A1.

4.3 Electromagnetic compatibility (EMC)

The detector assures sufficient level of electromagnetic compatibility that corresponds to the requirements to individual devices operating in the industrial environment. However it is the responsibility of the electric system designer as well as the fitter of electric equipment to assure that the entire installation shall comply with the applicable regulations and standards, including for instance requirements to the lightning-protection systems. It must be taken into account that the European Directive 2004/108/EC "Electromagnetic compatibility" the installer is responsible for performance of the electric system with regard to electromagnetic compatibility. However, compliance of the system components with the aforementioned Directive does not guarantee that problems related to electromagnetic compatibility shall be avoided on the stage of the system installation and commissioning (due to implementation of non-standard appliances, use of walkie-talkies, etc.). Such problems, whenever occur, must be solved individually by mutual agreements between the equipment manufacturer(s), the company that carries out the installation and the investor.

5 Installation and connections

5.1 General rules, legal background, applicable standards

General rules, relevant to

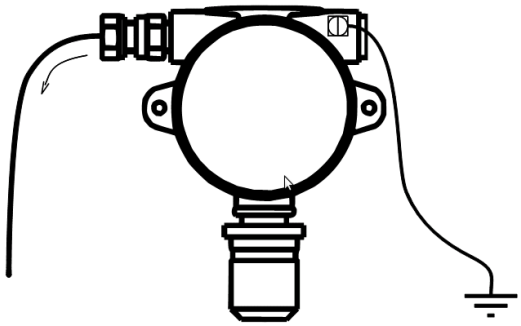
5.1.1 selection of detectors with regard to explosion-proof safety,
5.1.2 designing the electric systems for power supplying voltages and data transmission within the zones with potentially explosive atmospheres,
5.1.3 installation of electric systems for power supplying voltages and data transmission within the zones with potentially explosive atmospheres,
5.1.4 procedures of commissioning and take-over inspections,
5.1.5 procedures of scheduled inspections and maintenance **are governed by the following standards:**

- EN 60079-14,
- EN 60079-17.

Here below the manufacturer's comment is presented to point out the most important references of the above standards to the SmArtGas 3 / Sigma SmArt appliances. However, that does not absolve the designer, fitter, maintenance staff and other involved persons from the obligation to learn thoroughly the full content of the mentioned standards and adequate application thereof. The manufacturer of the equipment bears no responsibility for the way in which the system is designed, installed, exploited and maintained.

5.2 Protective earthing and cable routing

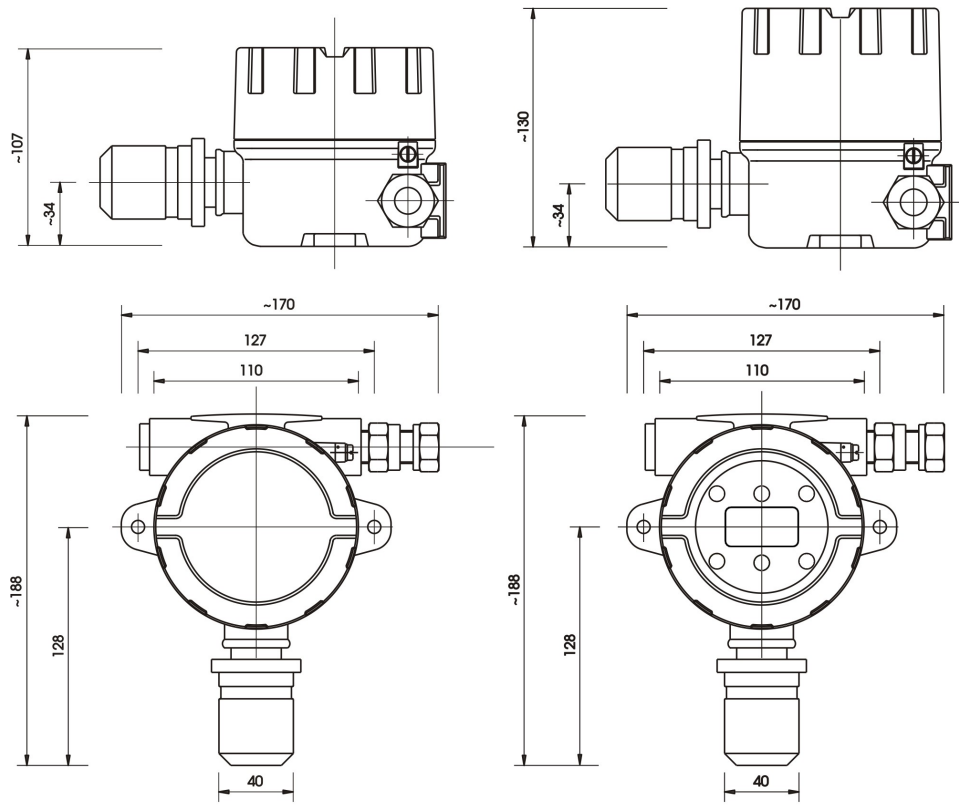
The detectors should be connected as shown below.



5.3 Mechanical fitting of the detectors

The detectors should be installed in such a way that the detector head points downwards and fitted through two mounting holes by means of expandable dibbles and screws or M5 bolts.

Optionally, the detectors are supplied along with spacing sleeves that makes it possible to mount the detector at some distance from the wall. This enables to shield the detector with splash-protecting covers or prevents from accumulation of moisture on the detector body if water drips down the wall.



5.4 Electric installations

The electric signal and power supplying systems for gas detectors installed in zones with potentially explosive atmosphere may only be carried out by authorized personnel who posses relevant qualification (e.g. approved inspectors who have rights to commission explosion-proof equipment) or by instructed employees who work in agreement and under guidance and supervision from the manufacturer.

The electric system must be installed in accordance with the design. If such a design has not been developed the remarks and instructions included in Chapter 4 of this document must be observed.

The applied flameproof cable gland makes it possible to thread cables with strictly specified diameters.

The electric connections must be carried out in accordance with the following sequence:

- make sure that the connected cables are detached from any electric circuits,
- make sure that no risk of explosion or fire may occur during installation work,
- unlock the detector cover by unscrewing four M3 securing bolts with hexagonal socket heads circumferentially deployed on the cover. Keep the bolts safe to prevent them from being lost,
- detach the detector cover,
- loose the cable gland,
- after having the cable endings prepared (stripped the insulation out) thread the cable through the cable gland,

> Note: Pay attention to the outer diameter of the cable as it should match the type of the cable gland applied.

- connect the wires in accordance with the electric diagram,

> Note: Pay attention to bare endings of the wires being connected to avoid shorts and sticking to non-insulated components of the detector.

- lay the cable properly, avoid strains and any other mechanical tensions and impacts,
- tighten the cable gland,
- attach the detector cover, make sure that the gasket is in place,
- screw in and tighten the securing bolts.

According to the state-of-art of the electric engineering the detector wiring should be laid as far as possible from the mains and power supplying cables, in separate cable ducts (if possible).

6 Commissioning and start-up of the system

6.1 Commissioning of the explosion-proof safety

The other end of the connecting cables can be attached to the power sources only after approving assessment of the connections made and after having restored the flameproof properties of the detector. The commissioning process should follow the guidelines and recommendations as included into the standard EN 60079-17.

6.2 Commissioning inspection

After the power supplying and data transmission systems have been completed the commissioning inspection of the system should be carried out in accordance with:

6.2.1 standard EN 60079-17,
6.2.2 technical documentation,
6.2.3 commissioning inspection report should comprise suggestion with regard to the first review inspection. The time to the first review inspection should be no longer than 6 months (3 months are recommended).

6.3 Start-up of the system

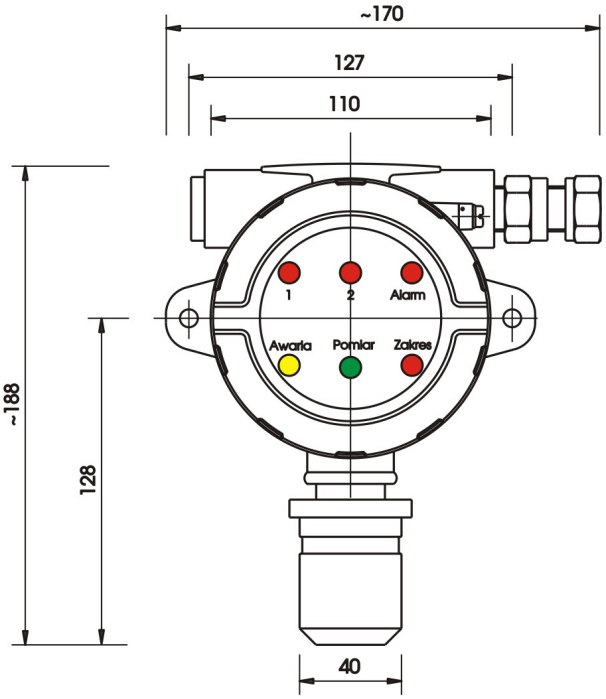
6.3.1 If possible, the start-up of the system is recommended to be carried out under conditions when the explosion hazard is not existent, e.g. during technological downtime of the entire plant. If such conditions prove to be unfeasible all the rules and regulations related to safe operation of electric equipment in the zones with potentially explosive atmosphere should be strictly obeyed,
6.3.2 In case of excessive large in-field systems successive connection of subsequent detectors is recommended and starting the up one after another. Such an approach makes location of possible faults easier and facilitates troubleshooting caused by installation mistakes,
6.3.3 Expected behaviour of the detector and its operation after energizing the unit (power on) are described in further parts of the present documentation.

After having installed all the electric connections, successful commissioning and start up the entire system is ready for operation.

7 User interface (only version D – LCD)

7.1 General remarks

The user interface of the detector equipped with a local display consists of:



- alphanumerical LCD displaying information about gas concentration values,
- (1,2) warning 1, warning 2 and alarm light indicators (red) – active when the gas detector detects a hazardous gas concentration above the defined value,
- (ZAKRES) gas overload (red) light indicator,
- (AWARIA) gas detector fault (yellow) light indicator.

Despite lack of the display the detector models marked with D – 0 perform identically as the models with the display module.

7.2 Self-test and preliminary warming-up

Energizing of the detector activates operation of the device. The detector switches subsequently all the indicators on and off while the user should verify operability of the display.

After about 60 … 180 seconds (depending on the sensor type) the appliance is switched to the normal operation mode.

7.3 Stand-by measurement

The detector measures concentration of a certain agent and converts the measured value into electric current or digital code, depending on the detector type. Beside execution of measurements the detector analyses level of the measured concentration and can produce signals that inform about exceeding the following threshold limits:

- warning 1 – gas concentration has exceeded the first threshold limit,
- warning 2 – gas concentration has exceeded the second threshold limit,
- alarm – gas concentration has exceeded the alarm threshold.

Exceeding the threshold limits is indicated by means of the alarm indicator (ALARM).

- single blink – warning 1,
- double blink – warning 2,
- continuous light – alarm.

Depending on the external conditions the detector can also indicate one of the following states:

7.4 Gas overload

Most of the gaseous sensors are able to operate exclusively within the specific range of concentration limits and are sensitive to overloads. The overload – in particular extended in time – may lead to the damage to the sensor – decrease or loss of its sensitivity. Such a damage can result in a significant hazard, therefore the modern detectors have the facility that makes it possible to detect overloads. Eventually, after the overload has occurred, the supervising staff is informed about the event and can undertake appropriate measures, e.g. test the detectors and adjust them if needed.

The detector that is described in this documentation not only reveals gas overloads but also thermal ones that are equally dangerous.

Depending on the overload duration the following types are distinguished:

- temporary overloads indicated by blinking the AWARIA (Failure) indicator and continuous lighting the ZAKRES (Range) indicator,
- critical overload during the overload indication as above, but after disappearing of the detected gas the ZAKRES (Range) indicator, keeps blinking that means that the failure was really serious and intervention of the servicing staff is necessary.

7.5 Emergency (failure) states

The detector are self-tested and self-diagnosed appliances and in case if any irregularities are found out during the self test the user is provided with information of the fact. Irregularities that may occur during exploitation of detectors can be of the two types: either those that make further use of the unit impossible and impose immediate intervention of the servicing staff or such ones that indicate symptoms of minor and negligible faults that the user should be informed about but the inspection and possible repair can be postponed to any convenient time. It is why the two types of failures are distinguished:

- non-critical failures – indicated by blinking the indicated by blinking the AWARIA (Failure) indicator and requiring to have the servicing staff informed,
- critical failures – indicated by continuous switching the AWARIA (Failure) indicator on and requiring immediate intervention of the servicing staff.

8 Exploitation and maintenance

The forthcoming description refers to rules of exploiting the SmArtGas 3 / Sigma SmArt detectors after correct installation thereof (see Chapter 5) and passing the commissioning and start-up (see Chapter 6).

During exploitation of the gas detectors the user must be aware that the detectors and even more the embedded sensors are the components that subject to the ageing process and that are sensitive to environmental impacts. It is why the scheduled maintenance procedures should be carried out on the regular basis. In general, inspection and maintenance covers two exploitation aspects:

- spontaneous changes in the detector characteristics,
- maintaining sound technical condition of the detector that guarantees its correct tripping.

In turn, changes in detector characteristics may refer to the three following issues:

- drift (bias) of the zero-point (tripping threshold) towards “positive” (higher) or negative” (lower) concentrations,
- decrease or loss of sensitivity,
- increase of the response time, which can likely be a result of contamination of the sintered member the gas migrates through and penetrates into the detector.

8.1 Rules of safe maintenance and service of gas detectors

8.1.1 Every person who carries out the tasks connected with maintenance and service of gas detector must be accordingly trained and possess relevant authorization rights adequate to the assigned tasks.

8.1.2 No maintenance operations can be carried out when the hazard of gas concentration is expected.

8.1.3 If the gas detector must be disconnected (dismounted) despite of the expected gas hazard the measurements must be carried on by means of an alternative system, e.g. by means of properly deployed portable detectors.

8.1.4 Taking measurements by means of the alternative equipment is recommended in every case when the basic system of gas detection must temporarily operate with confines.

8.1.5 The inspection / calibration process should be well-prepared and must be performed as quickly as possible.

8.2 General rules for checking and calibration of detectors

8.2.1 The detectors should be checked without dismounting thereof from the place of installation and even without opening the cover in the zones with potentially explosive atmosphere. However, in certain cases, dismounting of detectors for checking may prove to be unavoidable, e.g. in case of HCl detectors. Please refer to the document “Detailed exploitation terms and conditions“ for further information on the above issue.

8.2.2 The test is performed by supplying the test gas with concentration of the detected agent higher by 20% than the alarm threshold or with concentration of 50 … 100% of the measurement range and monitoring the detector performance. Detectors should be checked using manufacturer's Calibration Mask. Whether the detector has preserved its operability and can be still in use it should produce the alarm signal.
Bias (drift) of the detector characteristics can be of two types:

8.2.2.1 towards “negative concentrations” (decrease or loss of the sensitivity)
Supplying of the test gas makes it possible to detect any decrease of sensitivity high than 20% of the preset value. According to the rules as specified in the further part of this document, failure to produce the alarm signal after having the test gas delivered imposes the need of recalibration and adjustment.

8.2.2.2 towards “positive concentrations” (over sensitivity)
The drift (bias) is equivalent with decrease of the sensitivity threshold of the detector and can revealed by current monitoring of the detector indications. Even is observation is not carried out on the regular basis excessive drift (bias) results in undesired producing the first warning signal. As the detector can be tripped by background contamination it is recommended to check the operation condition of the unit by supplying the test fresh air in justified cases.

8.2.3 In spite of produced alarm signals it is recommended to monitor actual indications of the detectors, whenever the systems enable doing so.

8.2.4 The “calibration” function implemented into the detector design enables monitoring of the detector indications with no need to produce system alarms and raise panic to the entire vicinity. However, inspection of the entire alarm path – from the detectors to actuators – should be carried out at least for the some detectors (for all he detectors during commissioning).

8.2.5 The detectors are switched to the calibration mode by means of the relevant function of the service software.

8.2.6 The detectors should be switched into the calibration mode individually or as functional groups. It is convenient to carry out the calibration procedure by two-persons teams with permanent communication between the dispatcher and the operator e.g. by means of a walkie-talkie.

8.2.7 In case of large systems cyclical verification of the detector operability is recommended – an extracted group of detectors can be checked every day. For this purpose the detectors within the plant can be structured according to the chessboard principle, which increases efficiency of the test process.

8.3 Scheduled inspections

The scope of scheduled inspections should cover the following issues:

8.3.1 visual inspection in accordance with standard PN-EN 60079-17 that includes assessment of the general technical condition of the unit with regard to the explosion-proof safety as described in the preceding chapters of this documentation,

8.3.2 test of detectors
The detectors should be tested without dismounting them from the system, by supplying gas with test concentration of the measured agent, then correctness of the detector behaviour is checked.

8.3.3 checking the alarm part for the selected detectors
The inspection report should be developed after the inspection, the report should comprise recommendations and guidelines with respect to

- the need to carry out the maintenance for the entire system,
- the need to carry out calibration and adjustment of detectors.

8.4 Inspections imposed by exploitation conditions

In case of extreme crucial systems the detectors should be tested after each tripping and after every technological breakdown in the plant (whether the breakdown could affect the condition of the detectors but has not led to tripping of any – e.g. outflow of hot steam, etc.). The inspection criteria are established individually, in the way of mutual agreements with the plant technologists and are incorporated into the set of safety rules that determine safe exploitation of the system in the plant. They are developed by specialists who are responsible for safety matters of the entire plant or a specific technological line as well as take into account specific features of the plant. The staff that bears direct responsibility for safe operation of the gas monitoring system should be properly trained with respect to the safety rules effective on the plant area and they are obliged to commence relevant measures after the emergency situation has occurred.

8.5 Calibration of detectors – general rules

The calibration procedure should be carried out

- after the detector fails the operability test,
- after environmental overload of the detector,
- not less than
  - every 3 .. 12 months (depending on the plant type) for catalytic detectors,
  - every 6 .. 12 months (depending on the plant type) for electrochemical detectors.

If dismounting of detector is impossible by certain reasons calibration “on site” without dismounting detectors from the technological line is allowed. Decision on the calibration method is up to the investor (or another person(s) appointed by the investor who are responsible for safety matters in the plant) on its sole responsibility.

After adjustment and calibration the detectors must be retested to make sure that the system is free of any possible mistakes and omissions that might have happened during adjustment and programming. Calibration of detectors is carried out by the relevant software and consists in connecting a PC computer (e.g. a notebook) to:

- the data bus of the detector – for models with the RS-485 port,
- directly to the detector hardware – after uncovering the housing (junction box) – allowed only outside the zone with potentially explosive atmosphere.

The following calibration techniques are available:

8.5.1 laboratory method

Dismount the detectors and secure the cable endings according to the standard EN 60079-17, then carry out the calibration procedure in a laboratory under digestorium conditions.

8.5.2 direct method (only for conventional current loop 4 .. 20 mA and digital port by the RS-485 standard).

Connect a notebook computer directly to the detector – on site calibration with uncovering the junction box is allowed only for detectors that are operated outside the zones with potentially explosive atmosphere or during technological downtime of the installation with all the safety precaution applied, when the explosion-proof safety is monitored by means of an independent explosimeter and after necessary agreements with the plant operator.

8.5.3 remote method

Connect a notebook computer to the data bus of the system – outside the zone with potentially explosive atmosphere. It is the method that is recommended by the manufacturer. Its main advantage is that no mechanical operations with detectors (e.g. uncovering the junction box) are performed during calibration, except for screwing the calibration adapters and supplying the test gas. In addition, that method enables the system manufacturer to carry out the remote analysis of collected information provided for application of a method for remote data transmission – the WWW network, telephone modems, etc.

8.6 Calibration procedure

The calibration / adjustment procedure consists in:

8.6.1 switching the selected detectors into the calibration mode

The calibration mode is recognized by the Control Unit – this makes it possible to avoid raising undesired panic for the entire system caused by reaction of the detector under calibration to the test gas,

8.6.2 activation the recording mode of the supervising software,

8.6.3 supplying the sequence of test gases (“high concentration” / “pure air”, / ”high concentration”) subsequently to all the calibrated detectors. Indications of the detectors are automatically recorded by the service software tool,

8.6.4 analysing the collected information with calculation of corrective factors that are eventually entered into the programmed detectors,

8.6.5 switching the calibration mode off,

8.6.6 retesting the newly calibrated detectors.

The following parameters are specified during the calibration procedure:

- drift (bias) of the detector characteristic,
- contamination degree of the sintered member (measurement of the T90 reaction time),
- wear and tear of the sensor,
- electric power supply of the sensor (if applicable).

Details of the procedure are available from the service documentation of the software tools.

Calibration can be carried out exclusively by persons who have relevant authorizations issued by the manufacturer.

8.7 Repairs and alterations in the gas detection system

All the repairs and amendments should be carried out with special regard of the standard EN-60079-17 and in agreement with the system manufacturer. The user’s attention should be drawn of the standard – no unauthorized modifications or tampering with the detectors of its connections are allowed.

8.8 Taking out of service, temporary downtime

In case of the need to take any detector out of service (e.g. for calibration or maintenance) the regulations of the standard EN-60079-17 must be strictly obeyed, the dismounting procedure should be agreed with the manufacturer (if possible).

8.9 Sensor replacement

Degradation parameters of the sensor during its exploitation is a natural phenomenon, which is compensated by scheduled adjustment and calibration of the detector indications (see chapter 8.6) until the moment when replacement of the sensor proves to be indispensable. It is assumed to be done when the detector sensitivity decreases below 50% of the initial value.

8.10 Factors that may affect performance of the detector and its lifetime

8.10.1 Blocked access of the working agent into the detector interior

While operating be aware that every detector can indicate presence of only such an agent that comes into contact with the detector measuring electrodes. Every external obstacle on the way of undisturbed diffusion of the agent to the sensor area results in deterioration of the detector performance.

The obstacles can accrue both inside the detector itself and in the surrounding atmosphere.

That phenomenon may be caused by the following factors:

- accumulation (condensation) of moisture at the detector inlet,
- absorption of the detected agent by accrued moisture (in particular it refers to the substances that react with water or are soluble in water),
- sedimentation of rime onto the detector,
- accumulation of other stuff, e.g. condensates of solvents, dust, paint, grease, etc.

The above may lead to the following results:

- decrease of sensitivity,
- prolongation of the reaction time,
- total clogging of the sensor.

It should be also kept in mind that the sensor, which is inserted into the measuring head, is protected either by a sinter coating of metal powders or the PTFE membrane. Both the sintered member and the membrane are easily replaceable and their role includes capturing of solid contamination. Otherwise the sensor would be damaged in irreversible manner due to clogging the inlet capillary pipe. Therefore accumulation of dirt on the protecting members worsens performance of the detector but on the other hand it is favourable phenomenon, predictable and controllable.

The user should be aware of the existing phenomena and take them into account while scheduling the current activities as well as include systematic tests of the detector into the maintenance plan for the system.

If the detectors are installed outdoors they should be additionally furnished, if possible, with heating facilities to warm the devices up to the temperature by 5 … 10 °C higher than the ambient air. Such facilities are not included into the scope of supply for basic equipment of detectors.

8.10.2 presence of masking (detection-preventing) agents may lead to the situation that the detector fails to recognize the right working agent due to presence of another chemical that affects the sensor in opposite manner.

Mutually contradictory effect of carbon oxide and hydrogen onto relevant application – specific sensors can serve as a typical example.

There are no established rules for such coincidences, every case subjects to individual consideration in agreement between the plant operator and the manufacturer.

8.10.3 presence of agents that poison the detectors:

- for catalytic sensors – sulphur, chlorine or lead compounds,
- for electrochemical sensors – the phenomenon is less frequent however it may occur. Every case (combination of gases, type of the installation) subjects to individual consideration in agreement between the plant operator and the manufacturer.

8.10.4 Environmental overload of detectors – influence of high concentrations of gases

That phenomenon concerns every type of sensor but the effects may vary.

- In case of catalytic sensors:
  - concentrations above 100% of (LEL – Lower Explosive Limit) may lead to damage to the sensor as a result of excessively intensive process of gas oxidation on the active component,
  - starting from certain concentrations above specific thresholds, usually above the Upper Explosive Limit, the thermal conductometric effect become the predominant phenomenon which results in reversing the detector characteristic. Eventually, indications of the sensor at very high concentration will be unambiguous (exactly the same as for concentrations below 100% of LEL. The phenomenon leads to extreme hazard in closed areas (insufficient or lack of ventilation) for gaseous agents (e.g. methane),

    Measurable vapour concentration for various liquids under certain environmental conditions (ambient temperature, atmospheric pressure) is frequently limited by the fact of saturation the surrounding atmosphere with the said vapours. The user should be aware of the above phenomenon and take into account special properties of agents he has to deal with. It is why indications of the device should be considered with some kind of scepticism.
  - extremely high concentration, above 80% with simultaneous lack of oxygen may be recognized as atmospheres with co content of flammable agents. The user should be aware of the above phenomenon and take into account special properties of agents he has to deal with. It is why indications of the device should be considered with some kind of scepticism.
- In case of electrochemical sensors:
  - range of measurements for those types of detectors is frequently limited to several ppm. Concentration levels measured in percents present a very significant overloads to detectors (1% = 10 000 ppm) and may lead to damage to the sensor or to really significant decrease of its sensitivity and lifetime.

Detectors are equipped with facilities that find out and indicate extremely high concentration of gases. However it is necessary to keep in mind that indication that the range has been exceeded in no matter solves the problem of adverse effect of gases onto a sensor – it is impossible to cut off the gas flow into the detector interior.

8.10.5 Environmental overload of detectors – influence of temperature and moisture

The detectors should be exploited under environmental conditions that match the ones as described in this documentation. Exceeding the threshold limits may lead – in particular in case of electrochemical sensor – to the following effects:

- if relative humidity is lower than 10 percents (< 10%) the sensor may become exsiccated, which reduces its lifetime,
- if relative humidity remains as high as more than 90% (>90%) over a significant time interval the loss of leakproof properties of the sensor is likely to occur along with “pulverization’ of the coating caused by absorption of moisture from the ambient environment.

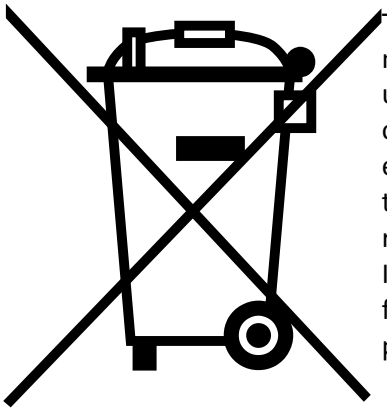
The above hazards present a real threat only if they have permanent or long-term nature. Short-term exceeding the above limits has no significant importance to the sensor lifetime.

8.10.6 Flooding of a detector

Flooding of the sensor measurement head may lead to damages to the sensor. The most hazardous situation occurs when the device is flooded by chemicals. The effects are unpredictable as even correct operation of the unit gives no warranty of future performance.

In case of the detector flooding please contact the manufacturer as soon as possible and notify about the event. Be aware of the possible need to replace the sensor.

8.11 Utilization



This symbol on a product or on its packaging indicates that the product must not be disposed of with other household waste. Instead, it is the user's responsibility to ensure disposal of waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The proper recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. Information about relevant designated collection points can be obtained from the Local Authority, waste disposal companies and in the place of purchase. The equipment can also be returned to the manufacturer.

9 Technical specification

Power supply • V_{CC} • Power consumption	 10 ÷ 30 V DC 0,4 ÷ 2 W (depending on configuration)
Environment[1] • Ambient temperatures • Humidity • Pressure	In-operation -40 ÷ 60 °C (T = 0 option) -40 ÷ 85 °C (T = T option) 10 ÷ 90% long term 0 ÷ 99% short term No condensation 1013 hPa ± 10%
ATEX	II 2G Ex d IIC T6-T4 Gb II 2D Ex tb IIIC IEC 60079-29-1 T4: -20 < Ta < 120 °C T5: -40 < Ta < 85 °C T6: -40 < Ta < 70 °C
Measuring range	Depends on the sensor used
IP	IP63 IP65 (when the water-splash shield PW-071 accessory is used)
Analogue output parameters (applicable SmArtGas 3) • R_{LOAD_MAX}	 200 Ω
Digital output parameters (applicable SmArtGas 3) • Relay	 Floating contacts, 3 x NO/NC 24 V DC / 0,2 A Not protected against overloading
Integrated signalling equipment (visual)	LCD alphanumerical display 2 x 8 with LED indicators (D = LCD option)
Protection class	III
Dimensions • Height • Width • Depth	 See section 5.3
Cable glands (cable diameter range)	3 ÷ 13 mm
Acceptable cables	0.5 ÷ 1.5 mm^2
Enclosure material	Aluminium, spray epoxy, SS316L
Weight	3,5 kg
Mandatory periodic inspection	Every 12 months (Calibration Certificate validity) Time may be reduced due to harsh working conditions
Mounting	Directly to the wall using pins Φ4 mm (2 pieces), hole spacing: 127 mm Using mounting adapters EM-072 /EM-073 / PW-063

Table 2: Technical specification

1 Environmental parameters are confined to the properties of the sensor.

10 Appendices

A1 PU-Z-041 – Routing of data transmission lines for gas detectors provided with RS-485 port

A2 DEZG-041 – EC Declaration of Conformity Gas Detector SmArtGas 3, Sigma SmArt

Routing of data transmission lines for gas detectors provided with RS-485 port

1 Preliminary information

It is recommended that all the system components were made according to the engineering documentation developed by designers with appropriate skills and /or competences.

2 Transmission cable

The data transmission line for detectors provided with an RS-485 serial communication port should be made exclusively of a shielded cable with twisted pairs.

The following shielded cables are recommended for integration of detectors provided with RS-485 ports and the field buses:

- outdoor systems with cables fixed to cable bridges or in cable trays running to individual devices (RS-485 12-24 V):

Cable specification code	Outer diameter [mm]	Wire resistance [Ω/km]
YvKSLYekw-P(9A) 300/500V 2x2x1	10.9 ± 0.5	18 ÷ 20
YvKSLXekw-P(9A) 300/500V 2x2x1	12.3 ± 0.5	18 ÷ 20
LIYCYv-P(9A) 300/500V 2x2x1	11.3 ± 0.5	18 ÷ 20
YvKSLYekw-P(9A) 300/500V 2x2x1,5	12.6 ± 0.5	12 ÷ 13.5
YvKSLXekw-P(9A) 300/500V 2x2x1,5	13.3 ± 0.5	12 ÷ 13.5
LIYCYv-P(9A) 300/500V 2x2x1,5	13.0 ± 0.5	12 ÷ 13.5

- indoor systems (RS-485 12-24 V)

Cable specification code	Outer diameter [mm]	Wire resistance [Ω/km]
YKSLYekw-P(9A) 300/500V 2x2x1	9.1 ± 0.3	18 ÷ 20
LIYCY-P (9A) 300/500V 2x2x1	9.5 ± 0.3	18 ÷ 20
YKSLYekw-P(9A) 300/500V 2x2x1,5	11.2 ± 0.5	12 ÷ 13.5
YKSLXekw-P(9A) 300/500V 2x2x1,5	11.9 ± 0.5	12 ÷ 13.5
LIYCY-P(9A) 300/500V 2x2x1,5	11.6 ± 0.5	12 ÷ 13.5

Symbols used in the cable specification codes:

- (9) – the cable with more accurate round cross-section, sealed under pressure (better tightness for Ex bushings),
- (A) – colours of wires compatible with the Atest-Gaz standard (used for larger orders for cable, typically > 300m).

When a large batch of cable is being purchased (> 300m) it is recommended that cables for detectors and field buses are ordered with the following colours of individual wires and outer sheathing:

- first pair
  - orange (+POWER)
  - black (GND)
- second pair
  - blue (AB+)
  - white (AB-)

Adherence to the above colours is recommended due to unambiguous identification of wires. Upon request, the detectors can be provided with connectors in the respective colours.
Due to discrepancies between specifications of cable diameters in data sheets and the actual diameters it is necessary to include the information about the actual diameters of cables necessary for connection of detectors in the submitted orders.

3 Power supply source

The power line should be designed in such a way that the voltage across power terminals of the detector does not drop below the minimum permissible level, even when the power voltage on the other end of the line assumes the lower possible limit.

The power supply system must be designed for the worst possible conditions. One has to assume that under emergency circumstances, in case of voltage shut-off, the standby voltage (supplied from batteries) can drop to the minimum level of 21.0 V (in case of a drop below that threshold the system is automatically disconnected).

4 Power supply for detector

For detectors with digital data transmission it is assumed that the power supply voltage can never drop below 10 V. Power consumption of sensors is constant within the range of allowed power voltages. Drop of power voltage entails growth of electric current consumption from the power source (power adapter).
For instance, if a detector needs 1W:

- for the power supply voltage of 24 V – the line current is 1 W / 24 V = 40 mA,
- for the power supply voltage of 15 V – the line current is 1 W / 15 V =67 mA,
- for the power supply voltage of 10 V – the line current is 1 W / 10 V = 100 mA.

5 Example – a system with a single detector

Problem: select a power supply cable for the following operating conditions.
Assumptions:

- power consumption of the detector: 1.5 W,
- min. output voltage of the power source: 12 V,
- min. permissible power voltage across the detector's terminals: 10.5 V,
- distance between the Control Station and the detector: 200 m.

Calculations:

- maximum consumption of electric current for the detector: 1.5 W / 10.5 V = 0.1429 A,
- permissible voltage drop on the power line: 12 V – 10.5 V = 1.5 V,
- maximum permissible resistance of the power line: 1.5 V / 0.1429 A = 10.5 Ω.

Cable selection:

- a cable with the wire cross-section of 0.5 mm^2:
  R (2x200m) = 36 / 1000 * 400 = 14.4 Ω > 10.5 Ω
  The cable resistance exceeds the maximum permissible resistance of the power line. Therefore, it fails to fulfil the initial requirements and cannot be used for the system in question.
- a cable with the wire cross-section of 1.0 mm^2:
  R (2x200m) = 18 / 1000 * 400 = 7.2 Ω < 10.5 Ω
  The cable resistance is less than the maximum permissible resistance of the power line. Therefore, the initial requirements are fulfilled and the cable can be used for the system in question.

EC Declaration of Conformity

Atest-Gaz A. M. Pachole sp. j. declares with full responsibility, that the product:

(Product description)	(Trade name)	(Type identifier or Product code)
Gas Detector	**SmArtGas 3,** **Sigma SmArt**	**PW-044**

complies with the following Directives and Standards:

- in relation to Directive 94/9/EC – Equipment and protective systems intended for use in potentially explosive atmospheres:

Marking	Certificate no.	Standards	Notified body
Ex II 2G Ex d IIC T6-T4 Gb	FTZU 08 ATEX 0005X	EN 60079-0:2012 EN 60079-1:2007	1026 Physical-Technical Testing Institute, Pikartska 7, 716 07 Ostrawa-Radvanice, Czech Republic
Ex II 2D Ex tb IIIC	KDB 12 ATEX 0056X	EN 60079-0:2012 EN 60079-31:2009	1453 Experimental Mine "BARBARA", ul. Podleska 72, 43-190 Mikołów, Poland
IEC 60079-29-1	KDB 12 ATEX 0056X	EN 60079-29-1:2007	1453 Experimental Mine "BARBARA", ul. Podleska 72, 43-190 Mikołów, Poland
CE 1026	FTZU 03 ATEX Q 004	EN 80079-34:2011	1026 Physical-Technical Testing Institute, Pikartska 7, 716 07 Ostrawa-Radvanice, Czech Republic

- in relation to Directive 2004/108/EC – Electromagnetic compatibility:
  - EN 50270:2006

Purpose and scope of use: device is intended for use in gas detection systems for residential, commercial and industrial environment.

This declaration becomes not valid in case of system change or rebuild without manufacturer's permission.

Gliwice, 26.11.2012

(Name and Signature)

Managing Director
Aleksander Pachole